lecithin and derivatives, lignin and derivatives, monoglycerides and derivatives, olefin sulfonates, phosphate esters and derivatives, propoxylated and ethoxylated fatty acids or alcohols or alkylphenols, sorbitan derivatives, sucrose esters and derivatives, sulfates or alcohols or ethoxylated alcohols or fatty esters, sulfonates of dodecyl and tridecyl benzenes or condensed naphthalenes or petroleum, sulfosuccinates and derivatives, and tridecyl and dodecyl benzene sulfonic acids. In the preferred embodiment of an amine salt, it is a C_8-C_{20} alkenyl succinic ester amine salts such as the reaction product of an alkenyl succinic anhydride with alkanol amine such as N,N-dimethylethanol amine, N,N-diethylethanol amine or the like.

Emulsifier Mixture (iii)

A mixture of (i) and (ii) is described in greater detail in USSN 09/761,482, An Emulsifier For An Aqueous Hydrocarbon Fuel, incorporated by reference herein.

The Water-Soluble Compound (in iv)

The water-soluble compound may be an amine salt, ammonium salt, azide compound, nitro compound, alkali metal salt, alkaline earth metal salt, or mixtures of two or more thereof and is described in greater detail in USSN 09/761,482, An Emulsifier For An Aqueous Hydrocarbon Fuel, incorporated by reference herein. These compounds are distinct from the fuel-soluble product (i) and the ionic or nonionic compound (ii) discussed above. These water-soluble compounds include organic amine nitrates, nitrate esters, azides, nitramines and nitro compounds. Also included are alkali and alkaline earth metal carbonates, sulfates, sulfides, sulfonates, and the like.

Particularly useful are the amine or ammonium salts such as ammonium nitrate, ammonium acetate, methylammonium nitrate, methylammonium acetate, ethylene diamine diacetate; urea nitrate; urea; guanidinium nitrate; and combinations thereof.

The water-soluble compound may be present in the water-fuel emulsion at a concentration of about 0.001 to about 1% by weight, and in one embodiment from about 0.01 to about 1% by weight.

Emulsifier (v)

In one embodiment the emulsifier (v) is the reaction product of A) a polyacidic polymer, B) at least one fuel soluble product made by reacting at least one hydrocarbyl-substituted carboxylic acid acylating agent, and C) a hydroxy amine

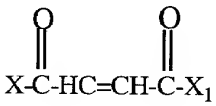
and/or a polyamine and is described in greater detail in USSN 09/761,482, An Emulsifier For An Aqueous Hydrocarbon Fuel, incorporated by reference herein.

The fuel soluble product is made by reacting at least one hydrocarbyl-substituted carboxylic agent with a hydroxy amine and/or polyamine and is described earlier in the specification.

The polyacidic polymers used in the reaction include but are not limited to C_4 to C_{30}, preferably C_8 to C_{20} olefin/maleic anhydride copolymers. The alpha-olefins include 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 1-tridecene, 1-tetradecene, 1-pentadecene, 1-hexadecene, 1-heptadecene, 1-octadecene, 1-eicosene, 1-docosene, 1-triacontene, and the like. the alpha olefin fractions that are useful include C_{15-18} alpha-olefins, C_{12-16} alpha-olefins, C_{14-16} alpha-olefins, C_{14-18} alpha-olefins, C_{16-18} alpha-olefins, C_{18-24} alpha-olefins, C_{18-30} alpha-olefins, and the like. Mixtures of two or more of any of the foregoing alpha-olefins or alpha-olefin fractions may be used.

Other polyacidic polymers suitable for reaction include but are not limited to maleic anhydride/styrene copolymers; poly-maleic anhydride; acrylic and methacrylic acid containing polymers; poly-(alkyl)acrylates; reaction products of maleic anhydride with polymers with multiple double bonds; and combinations thereof. The preferred is polyacidic polymer C_{18} [1-octadecene]/maleic anhydride copolymer.

In another embodiment the polyacidic polymer is a copolymer of an olefin and a monomer having the structure:



(I)

wherein X and X1 are the same or different provided that at least one of X and X_1 is such that the copolymer can function as a carboxylic acylating agent.

The olefin includes a polymerizable olefin characterized by the presence of one or more ethylenically unsaturated groups. The olefin monomers include but are not limited to 1-hexene, octadecene-1 and diisobutylene. The olefin preferably is a C_4-C_{30} olefin.

The emulsifier produced from the reaction product of the polyacidic polymer with the fuel soluble product (i) comprises about 25% to about 95% of fuel soluble product and about 0.1% to about 50% of the polyacidic polymer; preferably about

50% to about 92% fuel soluble product and about 1% to about 20% of the polyacidic polymer, and most preferably about 70% to about 90% of fuel soluble product and about 5% to about 10% of the polyacidic polymer. In one embodiment the emulsifier is described as a polyalkenyl succinimide crosslinked with an olefin/maleic anhydride copolymer.

Amino Alkylphenol Emulsifier (vi) and (vii)

The amino alkyl emulsifier is comprised of the reaction product of an amino alkylphenol, an aldehyde, and an amine resulting in amino alkylphenol. The amino alkylphenol can be made by (a) the reaction of alkylphenol directly with an aldehyde and an amine resulting in an alkylphenol monomer connected by a methylene group to an amine, (b) the reaction of an alkylphenol with an aldehyde resulting in an oligomer wherein the alkylphenols are bridged with methylene groups, the oligomer is then reacted with more aldehyde and an amine to give a Mannich product, or (c) a mixture of (a) and (b)

The alkylphenols have an alkyl group selected from C_1 to C_{200}, preferably C_6 to C_{170} wherein the alkyl group is either linear, branched or a combination thereof. The alkylphenols include, but are not limited to, polypropylphenol, polybutylphenol, poly(isobutenyl)phenol, polyamylphenol, tetrapropylphenol, similarly substituted phenols and the like. The preferred alkylphenols are tetrapropenylphenol and poly(isobutenyl)phenol. For example, in place of the phenol, alkyl-substituted compounds of resorcinol, hydroquinone, catechol, cresol, xylenol, amyl phenol, hydroxydiphenyl, benzylphenol, phenylethylphenol, methylhydroxydiphenyl, alpha and beta naphthol, alpha and beta methylnaphthol, tolylinaphthol, xylylnaphthol, benzylnaphthol, anthranol, phenylmethylnaphtol, phenanthrol, monomethyl ether of catechol, phenoxyphenol, chlorophenol, hydroxyphenyl sulfides and the like may be used.

The aldehydes include, but are not limited to, aliphatic aldehydes, such as formaldehyde; acetaldehyde; aldol (β-hydroxy butyraldehyde); aromatic aldehydes, such as benzaldehyde; heterocyclic aldehydes, such as furfural, and the like. The aldehyde may contain a substituent group such as hydroxyl, halogen, nitro and the like; in which the substituent does not take a major part in the reaction. The preferred aldehyde is formaldehyde.